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specimens from Cheyenne Canon, five miles below Colorado Springs, and has also found a few specimens in Glen Eyrie. She also reports that it is said to be abundant in Bear Creek Canon. It is still I think remarkable that this plant was not collected by any of the early explorers of this district, and it is probable that it is one of those cases where the appearance of man changes circumstances in favor of the rapid spread of plants which had little show in the unaided struggle for life in wild nature.

I may further remark that the width of the flowers sent me by my correspondent favors Mr. Jones' suggestion that *Aquilegia chrysantha* and *A. cærulea* are not specifically distinct.—THOMAS MEEHAN.

NOTE.—Since I sent you my note on the yellow *Aquilegia* at Colorado Springs, my correspondent writes that she has found two cases of pale blue flowers on the same plants as the yellow ones. I am glad to render this additional testimony to the accuracy of Mr. Jones' observations. The flowers however seem to be yellow forms of *Aquilegia cærulea*, and not to have the short sepals and petals in comparison with the spurs, which *A. chrysantha* has.—T. M.

Hieracium aurantium.—This foreign plant is not described in our botanical text books, and I judge is not generally known in this country. It is quite common here and is fast becoming a troublesome weed —W. H. LENNON, *Brockport, N. Y.*

Aplectrum hyemale.—Among a large number of specimens of this plant, collected a few weeks ago, at least one-third had flowers of a *greenish-yellow*, without the slighest trace of brown or purple, not even a speck on the lip. Is this variation common? The botanies do not mention it.—W. H. L.

Some New York Ferns.—At the village of Holley, about twenty miles west of Rochester, N. Y., the Rochester and Niagara Falls R. R. crosses a ravine up which, within a distance of less than two miles, are found the following ferns:

Polypodium vulgare, *Adiantum pedatum*, *Asplenium Trichomanes*, *A. ebeneum*, *A. angustifolium*, *A. thelypteroides*, *A. Filix-fœmina*, *Camptosorus rhizophyllus*, *Phegopteris hexagonoptera*, *P. Dryopteris*, *Aspidium Noveboracense*, *A. Thelypteris*, *A. cristatum*, *A. cristatum*, var. *Clintonianum*. *A. Goldianum*, *A. marginale*, *A. spinulosum*, *A. acrostichoides*, *Cystopteris fragilis*, *C. bulbifera*, *Onoclea sensibilis*, *O. Struthiopteris*, *Dicksonia pilosiuscula*, *Osmunda regalis*, *O. Claytoniana*, *O. cinnamomea*, *Botrychium ternatum*, *B. Virginianum*, *B. matricariaefolium*, *B. lanceolatum*.—W. H. L.

Botanical Handbooks For Tourists.—An excellent list of this kind has been published by Prof. G. L. Goodale in No. 9 of the Bibliographical Contributions from the Library of Harvard University. We print it here as we have so often received letters asking just the information this list gives so satisfactorily and this one answer will serve for many inquirers. The list is meant to comprise simply the most useful works for the determination of the flowering plants of the regions specified.

UNITED STATES.—NORTH.—Manual of the Botany of the Northern United States, including the district east of the Mississippi and north of North Carolina and Tennessee, arranged according to the natural system. By Asa Gray. New York. 8vo.

SOUTH.—Flora of the Southern United States; containing abridged descriptions of the flowering plants and ferns of Tennessee, North and South Carolina, Georgia, Alabama, Mississippi, and Florida, arranged according to the natural system. By A. W. Chapman, M.D. The Ferns by Daniel C. Eaton. New York. 8vo.

The two following works contain descriptions of the plants growing east of the barren western plains, both North and South. In the second the descriptions are much abridged:

Class Book of Botany. By Alphonso Wood. New York. 8vo.

American Botanist and Florist. By Alphonso Wood. New York. small 8vo.

WEST.—*Colorado.*—Synopsis of the Flora of Colorado. By Thos. C. Porter and John M. Coulter. Washington. 8vo. (Miscellaneous Publications, No. 4, of Professor Hayden's Geological and Geographical Surveys of the Territories.)

Utah and Nevada.—United States Geological Exploration of the Fortieth Parallel. Clarence King, Geologist in charge. Botany by Sereno Watson, aided by Professor D. C. Eaton and others. Washington. 4to.

California.—Botany. Vol. I. Polypetalæ, by W. H. Brewer and Sereno Watson. Gamopetalæ, by Asa Gray. Cambridge 4to. (Uniform with the publications of the Geological Survey of California.)

Vol. II. Apetalæ, Vascular Cryptogams and Mosses. By Sereno Watson and others.

THE BRITISH ISLANDS.—Manual of British Botany. By Chas. C. Babbington, F. L. S. London. small 8vo.

Handbook of the British Flora; a description of the flowering plants and ferns indigenous to, or naturalized in the British Isles. For the use of beginners and amateurs. By George Bentham, F. L. S. London. 8vo.

The Student's Flora of the British Islands. By Sir J. D. Hooker, Director of the Royal Gardens, Kew. London. small 8vo.

FRANCE—Flore des Environs de Paris. By Casson and Germain de Saint-Pierre. Paris. 8vo.

SWITZERLAND.—Flore analytique de la Suisse. Vademecum du botaniste. By P. Morthier. Paris and Neuchatel. 12mo.

GERMANY.—Synopsis floræ germanicæ et helveticæ, exhibens stirpes phanerogamas et vasculares, cryptogamas rite cognitas, quæ in Germania, Helvetia, Borussia et Istria sponte crescunt atque in hominum usum copiosius coluntur: (auctore D. Guil. Dan. Jos. Koch). Leipzig. 8vo. Also published in the German language.

ITALY.—Prodromo della flora Toscana, di Teodoro Caruel. Florence. 8vo.

THE EAST—Flora orientalis sive Enumeratio plantarum in oriente a Graecia et Aegypto ad Indiae fines hucusque observatarum auctore Edmund Boissier. Basle. 8vo. The parts already published extend through the order *Borraginaceæ.*

The Internal Hairs of Nymphæa and Nuphar.—In the *American Monthly Microscopical Journal* for June and July, Mr. Chas. F. Cox, F. R. M. S., gives a very interesting paper on the "Epidermal Organs of Plants." In taking up the physiological portion of the subject he considers that stomata are not only of use in evaporation, but are directly connected with the assimilative process, while hairs are connected with metastasis. From his discussion of internal hairs we make the following extract:

If we examine with the microscope a section of the leaf, or the petiole, of a plant from either of these genera (*Nymphœa* and *Nuphar*), we are at once struck by certain abundant, thickened, branching, unicellular structures scattered through the parenchyma and projecting into the intercellular spaces. These structures have long attracted the attention of microscopists, but not until recently have they been distinctly recognized as internal hairs. The standard text-books of the microscope, such as Carpenter's and the Micrographic Dictionary refer rather doubtfully to the resemblance between these bodies and the stellate external hairs of *Deutzia* and *Alyssum*, but they generally shyly avoid calling them plainly internal hairs. Some writers speak of them as "stellate parenchymal cells;" and on a purchased slide which I own, they are described as "stellate raphides." But out of the confusion and uncertainity which has prevailed with regard to these structures, there has gradually crystallized a clear and definite recognition of the fact that they really are epidermal organs, exactly analogous to the external hairs of terrestrial plants, such as we have been considering.

In the first place, the mere morphology of these structures confirms the idea of their being truly hairs. In their outlines they so closely resemble some of the external hairs with which we are familiar (for instance those of the genus *Arabis*), that their analogy is at once suggested to the observer. They seem, however, to be always unicellular growths, and transverse sections show them to be hollow. Over their surfaces are scattered the grains of silex, so characteristic of other hairs, and made particularly familiar to us by the hairs of the Deutzias. If one wishes a striking demonstration of the mere resemblance of these internal hairs to better known external hairs, he has only to split the petiole of *Nuphar* or *Nymphæa* by tearing, and view it with the binocular as an opaque object. This, of itself, will be convincing to most persons acquainted with the peculiarities of leaf hairs.

But, aside from configuration and other merely morphological considerations, the mode of distribution of these internal hairs is almost precisely like that of external hairs. If we take a thin section of a leaf of *Nymphæa*, cut parallel to its surface, and examine it as a transparent object (still better if we illuminate it with polarized light) we shall see that these internal hairs, like external ones, are associated with the fibrovascular system; and toward the margin of the leaf, where the tissues are thin and the veins small, we shall find that the hairs exist only upon the veins and not between them. This is quite in accordance with what we know of the habit of all hairs, as I have already explained.

If we take a transverse section of the leaf of *Nymphæa* or *Nuphar*, cut across the midrib, we shall be struck by another fact connecting these internal hairs with the epidermal system. We shall at once notice that from the upper side of the leaf—which is, under common circumstances, the only side exposed to the air, and is consequently the only side possessing a true epidermis—these hairs spring like stumps of trees in an inverted field. From end to end of the section they will be observed planted close together, their pedicels imbedded in or forming a part of the epidermal layer, and their branches spreading downward and inward through the underlying parenchymal tissue. This is very marked in stained sections, in which the hairs take a darker color than the surrounding tissues; but in an unstained section, polarized light differentiates the structures quite as well as the elaborate, double-staining process now so commonly employed. It is to be noted that this arrangement of the hairs is confined to the upper or epidermal side of the leaf, and that no similar arrangement is to be seen at any other part. The distribution of the hairs on the interior of the petiole of the water plants is somewhat different from their arrangement on the interior of the leaf, but it is closely analogous to the arrangement of hairs upon the exterior of the petiole of land-plants.

I have referred to the fact that these internal hairs are good objects upon which to use polarized light; and this is a point of no small importance in the argument for their being actually hairs. To any one acquainted with the behavior of vegetable tissues with the polariscope, particularly of vegetable hairs, the manner in which these internal structures of the *Nymphæaceæ* are affected by polarized light is strong confirmation of their claim to be regarded as epidermal organs and true hairs. The way in which they take different colors in the process of double staining, will be another affirmative argument with those familiar with that process and its effects. Suffice it to say in this connection, that these internal hairs behave in precisely the way, and take exactly the colors, that external hairs do.

That structures physiologically referable to the epidermal system should be found growing in the midst of the parenchymal system, is not altogether anomalous, for sections of the leaf and petal of *Magnolia grandiflora* reveal an abundance of thickened, irregular, unicellular structures scattered through the parenchyma, which, both in their appearance and in their mode of distribution, at once suggest some sort of similarity to the internal hairs of *Nymphæa* and *Nuphar*; but which, in my judgment, are parts of the glandular system of the Magnolia. Indeed, any true sunken gland my be regarded as an internal epidermal organ.

Plants which do not live either entirely in the water or entirely out of it may naturally be expected to occupy, so far as their oganization is concerned, a position intermediate between submerged plants and aerial plants. Such is the case with the Nymphæaceæ. While not relinquishing their dependence upon, and their connection with, the external atmosphere, they nevertheless provide against partial submergence, by an increase of their capacity for internal interchange of the gases necessary for their life and growth. In other words the amount of external surface exposed to the atmosphere being largely curtailed, by reason of their partial submergence, this loss is compensated for by a great increase in the amount of internal surface exposed to the air and gases contained in the intercellular spaces. By this enlargement of the intercellular spaces the inside of the plant becomes (if I may be allowed the paradox) to some extent, for physiological purposes, another outside; and the practical effect is the same as if there were less intercellular space, and more surface exposed to the outer atmosphere. To the same extent as the inside becomes practically a part of the outside, by reason of its exposure to surrounding air and gases, that part of the outside which is submerged becomes practically part of the inside, by reason of its exposure to the surrounding fluid.

In plants existing under such peculiar circumstances, we need not be surprised to find organs and tissues, which in strictly terrestrial plants are external, becoming internal. And so there is no *a priori* reason against the existence of internal hairs, or even of a whole internal epidermal system, in the Nymphæaceæ. But we have no warrant for looking for internal hairs in all partially submerged, or wholly aquatic, plants any more than we have for expecting to find external hairs upon all terrestrial or aerial plants. As a matter of fact hairs do not exist upon many land plants which seem to grow under the same circumstances and surroundings as others upon which hairs are found; and so, while *Nymphæa* and *Nuphar* are internally pubescent, *Nelubium* and *Brasenia* are internally glabrous. It is no easier to account for this difference in land-plants than it is in water-plants; but in both cases it is doubtless caused by some fundamental, physiological difference at present unknown.

That the great enlargement of the intercellular spaces in submerged, or partly submerged plants is for the purpose of facilitating the internal interchange of gases which, in plants, growing upon the land, would take place externally, is no new theory of my own. Sachs, in his "Botanical Text-Book," says:

"A submerged water-plant, for example, which contains chlorophyll, absorbs carbon dioxide from without, under the influence of sunlight; and at least a portion of the disengaged oxygen collects in the cavities. When it becomes dark this process ceases; the collected oxygen is now absorbed by the fluids of the tissues, and gradually transformed into carbon dioxide, which can again diffuse back into the cavities, but partially also through the layers of tissue into the surrounding water."

In the light of these facts we can perceive how the interior of a water-plant may become of more importance to it than the exterior, for most physiological purposes, and under the circumstances it is not strange that we find such important organs of the metastatic process as the hairs, transferred from the exterior to the interior, where the amount of surface exposed to the interchanging gases is many times greater than that exposed to the external atmosphere.

Treeless Prairies.—Mr. Thomas Meehan remarked that the absence of timber or arborescent growth on the grassy prairies of America still continued to be a matter of controversy, but he believed that in the light of accumulating evidence, we might now come to a positive decision in regard to the question. The most prevalent belief had been that trees would not grow on these prairies,—and we have had theories relating to soil or climate, to show why they could not grow. Then there were others who believed that trees did grow there in ancient times, but had been burnt off and kept burnt off by annual fires.

Mr. Meehan considered in detail the authors who had propounded various theories, and the distinguished men who had advocated them, and said that it was evident climate could have nothing to do with the question, because in these prairie regions there were often large belts of timber lands, projected like huge arms into the grassy regions, with precisely the same climatal conditions over both. That the soil was not unfavorable, was proved now by the artificial plantations everywhere successtul, and that the soil was unfavorable to the germination of tree seed, as suggested by Prof. Whitney, was on the face of it untenable from the fact that it required but the same conditions for the seeds of trees as for those of herbaceous plants, the number of species of which on the prairies was well known to be very large. Another great gain to our present knowledge was that since the annual firing of the grassy prairies had been discontinued by the advance of civilization, the timber was everywhere encroaching on them. Among the facts which he offered in proof of this, was a reference to p. 505 of the 7th Report of the Geological Survey of Indiana, where Dr. Schneck shows how land which was once grassy prairie, is now covered with a luxuriant growth of forest trees; to the evidence of Major Hotchkiss, Geologist of Staunton, Virginia, that the Shenandoah Valley, now heavily timbered, was clear of trees in the early history of Virginia; to the discovery of buffalo bones, in caves near Stroudsburg, Pa., by Dr. Joseph Leidy,—now a timbered region, the buffalo only existing in open, grassy countries;* and to various traditions of settlers in some valleys now timbered, that the land was once clear of trees. He pointed out that in all known parts of the United States at the present time, except the arid regions, where only drought-loving plants could exist, the natural result of freedom was the succession of forest growth. Seeds were scattered by winds or animals over acres of cleared land; if such land became neglected, these, again seeding in time, extended the forest area continually. The tallest growing vegetation, like trees, crowded out the weaker, and the forest naturally crowded out the lower growing and weaker herbaceous plants. He illustrated this by reference to the neglected cotton-fields of the Southern States.

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*Since the reading of the paper, it has been brought to the attention of the author, that the bones may have belonged to the Wood Buffalo.

From all this, the speaker said that it was evident that there was nothing in Nature either now or in the past, to prevent the gradual encroachment of the forest over the grassy plains, till long before the white man came here, the whole would have been completely covered by arborescent growth, Were there any artificial causes equal to the exclusion of trees, and yet permitting an herbaceous growth? If we were to sow a piece of land in the autumn wtih some tree seed and some seeds of annuals, the latter would be up, flower, mature and scatter their seed to the ground before the next autumn, and many of these seeds would be washed into the earth, or drawn into the earth by insects or small animals. But tree seed would make young trees, which would not again produce seed for ten or more years. If now, at the end of this first season, a fire swept over the tract, the seeds of the annuals which had found a slight earthy protection, would come up again the next summer, again seeding and extending the area. The trees would be burned down, and though perhaps many would sprout, successive burnings would keep them confined to one place. In short, under annual burnings, herbaceous plants could still increase their area annually, but trees could never get far beyond the line they had reached when the annual fire first commenced. There could be no doubt that an annual burning in a tract destitute of forest growth, would certainly prevent the spread of timber, or of any plant that required more than a year to mature seed from the time of sowing. Now, if we look at the actual facts, we find that the Indians did annually fire the prairies.

Father Hennepin, the earliest writer on Indian habits, noted that it was the practice in his time. There is but little doubt but this practice of annual burning has been one extending long into the past. What object had they in these annual burnings? They must have known that the buffalo and other animals on which they were largely dependent for a living, throve only on huge, grassy plains, and that it was to their interest to preserve these plains by every means in their power. Low as their power of reasoning may be, they could not but have perceived that while grassy herbage throve in spite of fires, perhaps improved under the fiery ordeal, trees could not follow on burned land. What could be more natural than that they would burn the prairies with the object of retaining food for their wild animals? If we have no difficulty in reaching a positive conclusion so far, we may now take a glance at the early geological times. Mr. Meehan then referred to the researches of Worthen, Whittlesey and others in Ohio, Illinois and other prairie regions. On the retreat of the great glacier, the higher lands and drift formations were probably high and dry long before the immense lakes formed from the melting and turbid waters ceasedto be.

It was tolerably well understood that many species of trees and other plants which required a temperate atmosphere, retreated southwardly with the advance of the glacier, and advanced to higher latitudes on the glacier's retreat. Thus these higher ridges would become timbered long before the lower lands became dry. Evidence accumulates that man existed on this continent, in the far west, not long after the glacier retreated, though "not long," in a geological sense may mean many hundreds of years. The lakes of glacial water would gradually become shallower from the deposit of the highly comminuted material brought down from higher land, from the wearing away of rocky breastworks as in South Pass, Ill., as well as from the openings which would continually occur from nature's ever varying plan of streams under ground. In all events, the drying of these lakes would be from their outward edges first. Aquatics would give way to marsh grasses, and these to vegetation such as we now find generally spread over the prairie region. If now we can conceive of human beings such as we know the Indian races to be, already in more southern latitudes—having learned the fact that firing would keep down trees and aid in the preservation of the chase—following the retreat of the glacier to the higher lands, and still as they advanced northwardly, firing the plains up to the water's edge, it would certainly account for the absence of arboreal vegetation from these immense lacustrine lands from the very beginning of their formation. Of course with thisview we should have to look for some evidences of man's existence, both on the lands which were once under water, as well as those whichwere timber lands at his first appearance there. He did not know how many such evidences have been or may be found. Man's traces in the past are at best but rare, and they would naturally be much more scarce in the lacustrine regions than in lands dry at the same epoch. At any rate, this part of his remarks he said, must be taken as mere speculation ; but as we could see on the basis of sound scientific investigation why there could be no trees on these grassy prairies within the range of indubitable history, it was a fair inference that some such cause had continued from the beginning ; namely, that annual fires had ever been the reason why arborescent vegetation had never had an existence there.—*Proc. Phil. Acad.*

Catalogue of Michigan Plants.—This catalogue of 105 pages is the work of Chas. F. Wheeler and Erwin F. Smith of Hubbardston, Mich. There could not well be a finer state, botanically, than Michigan. Cut up as it is into two peninsulas, with its diversified conditions, it seems rich in rare plants. The catalogue is confined to Phanerogams and Vascular Cryptogams, and numbers 1,634 species. It contains a colored map of the state and a preface describing the general botanical features. The price is fifty cents and the authors well deserve some acknowledgement of their laborious work.